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Policies in coastal wetlands: Key challenges

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ABSTRACT

The role of public policies in protecting coastal wetlands is gaining in prominence. The goal of this paper is to review the research themes and the key challenges of coastal wetlands policies. We found 259 papers that cover five research themes: development and impacts, territory, local population, governance, and management. Half of the papers are study cases from North America, and South and Southeast Asia. Regional patterns show that researchers in North America and West Europe focus on the themes of governance and management, while scientists in Latin America, Asia and Africa concentrate their efforts on development and impacts and local population. The paper concludes that development policies are affecting coastal wetlands by promoting or allowing urban and economic activities to grow out of control; territorial planning is mismatched with ecological dynamics and influenced by economic interests; the government must build adaptation and a collaborative, multilevel, and decentralized system to achieve the integration of local population in decision-making. Adaptation in the governance improves conservation, restoration, mitigation and compensation, which are significant factors considering the disastrous effects of climate change.

1. Introduction

Coastal wetlands are strategic ecosystems with respect to food security, environmental protection and disaster risk reduction. Their functions include providing habitat for flora and fauna, mitigating floods and storms, retaining sediments, controlling erosion, and storing carbon (Barbier et al., 2011). In spite of the environmental and socioeconomic importance of wetlands, more than 64% of them disappeared in the twentieth century, and it is projected that their loss and environmental degradation will increase in the next years (Gardner et al., 2015). The impacts on coastal wetlands will intensify climate change, especially with regard to Sea Level Rise (SLR) (Erwin, 2009; Gilman et al., 2008).

A policy concerns how public problems are defined, managed and resolved by governments (Parsons, 2006). Environmental policies have an increasing role in stemming the loss of coastal wetlands. With the help of environmental policies, governments establish objectives, regulations and actions that actors must comply with to protect and use natural resources. However, there are also policies pertaining to economic development, which encourage intensive activities affecting coastal wetlands through changes in land use and urban discharges. These policies also promote activities that build dikes and fill and drain wetlands (Mitsch and Gosselink, 2015). These competing environmental and economic policies are evident in the territory, where issues and conflicts emerge as a result of accessing and using natural resources (Friess et al., 2016). Thus, decision-making is carried out in a complex governance structure, because multiple actors with varied interests compete or collaborate with each other.

The rise in the number of papers about policies relating to coastal wetlands is making it difficult to secure a clear vision of policies about wetland research and the advances made and obstacles faced in conservation and restoration. The goal of this paper is to review research themes and the key challenges of coastal wetlands policies, which have been researched by the academic community in the last few years. The results will present an actual idea of the problems discussed in the scientific arena as well as provide insights that will be useful for policymakers interested in different issues about coastal wetlands.

2. Materials and methods

A wide review of scientific literature was conducted in 2017. The databases of: ISI WEB OF KNOWLEDGE, SCIENCE DIRECT, WILEY, SPRINGER, EBSCO and SCOPUS were consulted. A Boolean search was carried out in the fields of title and abstract with the following keywords: (“POLICY”) AND (“COASTAL WETLAND” OR “LAGOON” OR “MANGROVE” OR “ESTUARY” OR “MARSH”). This search was limited

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to articles published between 2000 and 2016 in order to explore the challenges at present of policies. We are aware that this review doesn't cover studies in grey literature, databases of non-English languages, and other types of wetlands—for example, freshwater wetlands and vernal pools—but the results might supply information needed for policy-makers, researchers, and other people interested in this theme.

In the beginning, 1704 registers were found, of which 900 were repeated and eliminated. Interdisciplinary or transdisciplinary articles were included, but those belonging to particular disciplines such as biology, coastal engineering, oceanography and other topics were excluded, as research policies did not fall under their purview. Besides, articles about wetlands without the influence of coastal zones were excluded, but some articles about coastal basins, marine wetlands and other marine ecosystems were included. They were identified as review articles (Carter et al., 2015; Dale et al., 2014; Datta et al., 2012; Friess et al., 2016; Walters et al., 2008), which frequently referred to 21 articles that did not appear in the databases, so they were included in this review. At the end, 259 papers were selected.

Once the selection of papers was completed, a qualitative data analysis was applied to each text using *MAXQDA v. 12*. The relevant segments of each paper were coded according to the research issues that they referred to. While advancing in the readings, equivalent or similar codes were classified into groups of categorical variables. These groups of categories refer to different themes and sub-themes of research about policies relating to coastal wetlands. For instance, a paper may have more than one relevant segment coded, with one or more codes, or classified into one or more categories.

Five themes of research, which were closely related, were found (Fig. 1). Each theme contained many sub-themes. It was common to find that the majority of articles worked with more than one of these themes and subthemes, building relations among them (Figs. 2).

To describe the agenda of research, the variables of publication year, journal, first author, first author´s institution, institution's country and study regions were extracted from all the articles. Thereafter, a multiple correspondence analysis (MCA) was applied to detect patterns between groups of categories and some variables. For this purpose, the *IBM SPSSS v 22* software was used.

It was found that between 2000 and 2016, 50.4% of papers were published in the last 5 years. The review found that around 50% of papers are study cases from North America and South and Southeast Asia. Furthermore, Latin America and The Caribbean are important regions for scientists, because 13% of the researches were carried out

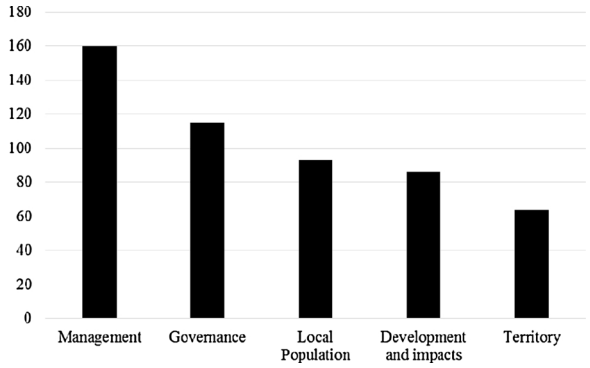

Fig. 2. Number articles and themes of research, an article may include more than one theme.

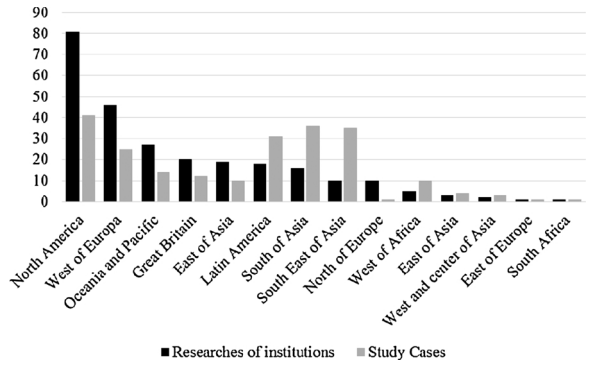

Fig. 3. Regions of institutions research and study cases.

there. The countries with more studies are: United States (14%), Brazil and Vietnam (5%), China (4.5%), Bangladesh and England (4.2%). However, the data based on first authors' institutions are a bit different. The majority of institutions were from North America, Western Europe, Oceania, and the Pacific Islands (Fig. 3). The institutions from these regions contributed to research study cases of tropical wetlands in Latin America and Asia.

MCA (Fig. 4) indicated that there was a correlation between the category of theme and the variable of region. But the variable of year did not have influence, so it was excluded from the figure. The theme of

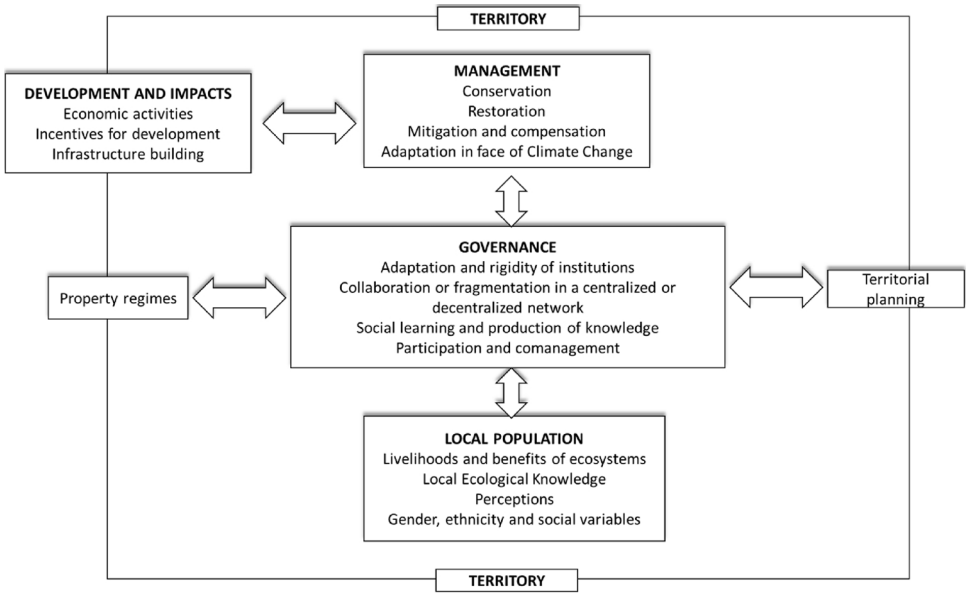

Fig. 1. Schematic view of main themes and sub-themes of research on policy in coastal wetlans.

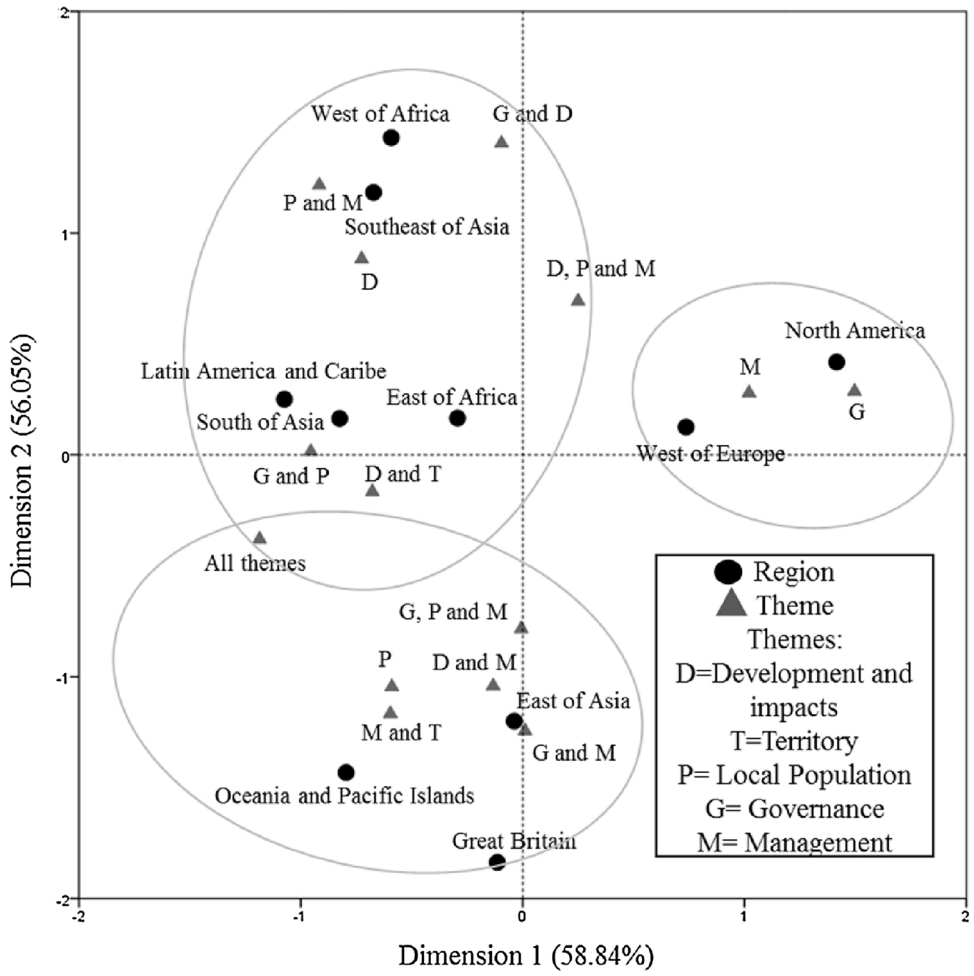

Fig. 4. Multiple Correspondence Analysis.

management has received much attention in all the countries. MCA identified that management and territory have always been studied with other themes, so they are considered as complex problems of research. Most of the studies from North America and Western Europe focused on governance and management. In contrast, most of the studies in Latin America, Africa and South and Southeast Asia were more interested in development and local population. MCA showed that studies in Oceania and Pacific Islands, Great Britain and the East of Asia researched almost all the categories, with an emphasis on management.

3. Results

3.1. Development and impacts

Policies for development increase economic and urban activities in coastal wetlands through tax exemptions, subsidies and financial credits. They promote economic development by controlling prices of natural resources such as water, minerals, carbon, and land. The State also provides facilities and resources, legalizes land tenure, allocates users rights, grants permissions, gives material resources, and stimulates capacities for production through educative and information campaigns (Adger and Luttrell, 2000; Greiner et al., 2000).

Policies for development finance the construction of embankments and drainage systems with the aim of controlling hydrodynamic processes (Rosa-Velázquez et al., 2017). Although these structures can be built to control flooding, they are also built to use lands, which in natural conditions, could not be exploited. In the same way, the State grants permissions to filling coastal wetlands, especially when they are represented as “wastelands” that have to be reclaimed for economic development. Historical studies in China exposed how coastal wetlands were reclaimed for agriculture and urbanization, which in turn led to the accumulation of environmental impacts (Bao and Gao, 2016; Xue et al., 2004). A study case from the Camargue Biosphere Reserve (France) indicated that controlling hydraulic regimes of coastal wetlands’ responses to economic demands generates impacts on socio-ecological systems (Mathevet et al., 2015).

Building transport infrastructure is financed by policies with the aim of increasing the accessibility to coastal wetlands. Studies have presented how the integration of a locality in the regional and international market, through transport infrastructure, produces environmental impacts on coastal wetlands. A paper indicated that mangroves areas far from Bangkok (Thailand) are less exposed to be converted than mangrove areas closer to the city (Barbier and Cox, 2004). Local communities in Sri Lanka perceived impacts because of road and dam developments (Satyanarayana et al., 2013). Among small fisheries in Nicaragua, environmental changes occurred after road constructions (Stevens et al., 2014). In Australia, artificial channels have impacted estuaries, reduced the water quality, and altered the hydraulic regimes and sediment transport (Harvey and Stocker, 2014).

Besides, economic and urban activities are not encouraged only by formal incentives, especially in developing countries. Huitric et al. (2002) showed that the shrimp industry grew in Thailand due to the lack of regulation and its incomplete implementation, cheap prices of land and water, and low sanctions. Primavera (2000) explained that corruption, weak law enforcement, and lack of political will, influenced the conversion of mangroves in Philippines. Studies have revealed that

when the State is not strong enough to control the territory, it is not able to protect coastal wetlands in the face of urban and economic activities (Hein, 2002).

According to this review, some authors explore the political forces behind the conversion of coastal wetlands. The market affects policies which leads to groups with power and economic interests moving to control decision making; overpopulation and poverty intensifies the depletion of natural resources and causes environmental impacts which get unequally distributed over the local population. The major obstacle is establishing a causal relation between policies and environmental changes, but the authors base their study on the fact that policies influence the behavior of actors (Islam et al., 2017; Martinez-Alier, 2001; Mathevet et al., 2015; Webb et al., 2014). There are authors who research mechanisms to integrate environmental protection in policies for development. They focus on factors, mechanisms, and actions related to sustainability. For them, the enforcement of environmental regulations becomes a driving force in adopting sustainable systems, with strong institutions and capacities to monitor the territory. However, regulation is not enough. Other incentives, such as financial programs, participation and empowerment, awards, information, education, accreditations, exemptions, etc. are also necessary (Canu et al., 2011; Greiner et al., 2000; Ilman et al., 2016; Joffre et al., 2015; Marschke et al., 2014; Queiroz et al., 2013; Walters et al., 2008).

3.2. Territory

3.2.1. Territorial planning: how much space do coastal wetlands need?

Territorial planning implies the delineation of protection areas, zones, setback lines, or buffers in coastal wetlands. However, establishing boundaries is controversial because of economic interests (Burley et al., 2012; Carter et al., 2015; Parr et al., 2011; Rogers et al., 2016). The discussions and claims are related to the influence of scientific knowledge and power relations in making decisions regarding spatial boundaries, and with the importance of delineation of coastal zones with rising sea levels.

Delineation and zoning coastal wetlands must be influenced by scientific knowledge. It takes into account physical and biological factors such as precipitation, geomorphology, tides, flow of rivers, soil, vegetation, and fauna (Flitcroft et al., 2016; Gibbs et al., 2007; Junk et al., 2014). However, the designation of spatial boundaries is affected by a lack of scientific knowledge (Xie et al., 2012). Territorial boundaries are rarely congruent with ecosystem dynamics and they are produced by power relations between multiple stakeholders with different interests and levels of influence in decision-making (Olsen and Christie, 2000). Karstens et al. (2007) pointed out that actors have their own visions about space. They consider different scales, which are based on their own preferences, to set boundaries. Consequently, the extension and regulations of protected areas depend on the actors involved in territorial planning. Also, there is jurisdiction overlap because of the location of coastal wetlands, encompassing both land and sea. The boundaries are not clear, which makes it difficult to designate responsibilities in the management of coastal wetlands (Walters et al., 2008). Setting boundaries in coastal wetlands is a complex and uncertain decision. Authors ask how much is enough to protect biodiversity? (Trisurat, 2007). How much space does coastal zones need? (Doody, 2013; Pethick, 2002). How much space is necessary for conservation and restoration of coastal wetlands?

Delineation of coastal wetlands is becoming more relevant in the face of SLR. Although accurate knowledge of spatial changes at the local scale is not available, authors discuss the need for establishing zones for retrieving the zones adjacent to coastal areas, wetlands, deltas, and estuaries to obtain the space necessary to achieve an ecosystem adaptation. The projections of the impacts of SLR on coastal wetlands is an emerging theme, and the decision makers' attention on this topic will probably increase in the following years (Doody, 2013; Pethick, 2002).

3.2.2. Property regimes

Authors research how the different types of properties may restrain or facilitate the protection of coastal wetlands, and how delineating boundaries affects or influences property regimes (Faraco et al., 2016; Gibbs et al., 2007; Leith et al., 2014; Xie et al., 2012). Coastal wetlands may be public, private or common property, depending on the constitutional norms, laws and the context of each State and community. There are also spaces of open access, where there is no clarity as to the property regime and the user rights, so the exploitation of natural resources is carried out by actors with the ability and resources to do it (Berkes, 2005; Memon and Thapa, 2016).

Most of the papers criticize the capacity of the State to protect coastal wetlands, as they are public property, especially in developing countries. The fragmentation of authorities, institutional failures, low economical resources, corruption, lack of political will, and the pressure of economic actors, may reduce the capacity of the State to protect coastal wetlands. Therefore, coastal and marine zones in the public domain may become spaces of open access (Aswani, 2005; Luttrell, 2001; Mangora, 2011; Memon and Thapa, 2016; Primavera, 2000). Illegality is rampant when the State does not have territorial control over coastal wetlands (Feka and Manzano, 2008; Ferreira and Lacerda, 2016). As Roy et al. (2012) noted in Bangladesh, institutional failures facilitate the illegality and overexploitation of natural resources.

When coastal wetlands are considered private properties, there is more overexploitation due to the competition between the users of natural resources (Adger and Luttrell, 2000; Wilkinson and Salvat, 2012). The private property rules restrict conservation and restoration of coastal wetlands, especially when the legal right of private property is more important than the environmental regulation (Huitric et al., 2002; Primavera and Esteban, 2008). Durigon et al. (2012) explained that wetlands regarded as private goods are managed with the purpose of extracting their natural resources. Some authors have discussed that privatizing coastal wetlands and marine zones is a strategy to gain access to natural resources and exclude local actors (Ha et al., 2014; Mansfield, 2004; Marschke et al., 2014; Martinez-Alier, 2001).

The common regime works if there is a high dependence on natural resources, equal distribution of benefits, cooperation and communication, mechanisms to conflict resolution, clarity in spatial boundaries, and local capacities to monitor and control the territory (Berkes, 2005). Common regimes are constituted by the local culture, so policies unaware of traditions in natural resource management cause conflicts and problematic environments (Walters et al., 2008). The political and legal support for commons is important in the face of global and regional market pressures (Beitl, 2012). The common property has been demonstrated to be an incentive for the sustainable use of natural resources (Armitage et al., 2011; Greiner et al., 2000).

Territorial conflicts occur as a result of disputes pertaining to the access and use of natural resources. For instance, when different property regimes overlap and contradict the spatial boundaries of environmental policies. Conflicts are also produced because of activities conducted outside of coastal wetlands, due to their connectivity with the river basins and sea. Coastal wetlands have high connectivity with other ecosystems; on multiple scales, there are overlaps of different actors who appropriate natural resources (Hodge and McNally, 2000).

3.3. Local population

Researchers have been interested in how policies for development or conservation impact livelihoods and traditional uses of natural resources, which in turn affect coastal wetlands. Authors have indicated that the lack of livelihoods has stimulated undesirable practices because people have been forced to look for subsistence due to the depletion of natural resources. Studies have revealed that people converted wetlands for other land uses; some authors explain that the symbolic power and incentives of policies affect the belief system surrounding nature, and lead to the belief that development promoted by economic forces is

the solution to improving living conditions (Acharya, 2002; Adger and Luttrell, 2000; Aheto et al., 2016; Armitage, 2002; Datta et al., 2012; Feka and Manzano, 2008; Ha et al., 2014; Islam and Wahab, 2005; Martinez-Alier, 2001). In addition, authors have researched how conservation policies ban, restrict, or permit traditional uses of natural resources. If the establishment of protected areas excludes the local population, it will, restrain the user rights and reduce livelihood diversification (Faraco et al., 2016; Roy and Gow, 2015; Satyanarayana et al., 2013). Some cases have demonstrated the potential of sustainability-strengthening livelihood strategies (Datta et al., 2012). However, authors have discussed that the narratives of environmental policies must change, because they consider local population as a threat, and not as an actor of conservation. They have the misconception that people, especially the poor, are the culprits of environmental degradation (Glaser and Oliveira, 2004; Mangora, 2011; Walters et al., 2008).

Authors have studied local ecological knowledge (LEK) and perceptions of environmental changes, because they provide information about dynamics of coastal wetlands, impacts of economic and urban activities, and traditional management of natural resources. Based on LEK, the communities establish norms, rules and mechanisms that are useful for the protection of coastal wetlands. The authors agree that policies must take into account the LEK, as it contributes to social learning and promotes participation (Almudi & Kalikoski, 2010; Armitage & Marschke, 2013; Levine et al., 2015; Rist & Dahdouh-Guebas, 2006).

Researches have explored perceptions about policies and management. It gives insight into policy acceptability and the causes of illegal practices. They have revealed that without people's support, policies fail. The perceptions indicate the way that people consider the State, the laws, the public problems, and the collective actions (Gregory & Wellman, 2001; Lubell, 2003; Maijerink, 2008; Pethick, 2002; Roy and Gow, 2015). A study case in New Orleans presented how perceptions influenced policies of coastal wetlands, as people changed their vision about the key of wetlands in city planning (Colten, 2002). In another paper, the analysis of perceptions helped to understand the illegality of marine fisheries in Bangladesh. Based on respondents' perception, it was found that illegality is related to poverty, incentives, lack of capacity, environmental education, and livelihood reduction (Islam et al., 2017). Illegal practices found in the literature are related to the occupation and exploitation of natural resources in protected areas, deforestation or collection of wood, harvesting, utilization of some fishing gears, wildlife hunting, induced forest fires, and livestock grazing. There are several factors related to the acceptability of a policy and the illegality, some of which are political and economic, such as legitimacy, inequity, institutions, and participation.

They were a few studies about social and cultural variables that influence policies and management of coastal wetlands. These variables are social class, income, educational level, gender, and ethnicity. The research of Lau & Scales (2016) indicated how these variables have determined the mangrove oyster harvesting among a women group in Gambia. The paper of Bauer et al. (2004) revealed that public preferences about compensation of saltmarshes differ in accordance with the educational level and incomes of population.

Finally, some studies have indicated that the valuation of ecosystem services is a tool for understanding how the local population benefits from wetlands (Barbier et al., 2011). Policies have a conception of wetlands that reflects the valuation of decision makers, and it defines the actions to deal with environmental degradation (Durigon et al., 2012). The conception of wetlands in policies may include or exclude the perspectives of the local population. When decision makers undervalue wetlands without realizing its benefits, the possibility of conversion of wetlands for other land uses increases. However, few studies have discussed the ways to match ecosystem services with political frameworks (Holt et al., 2011; Nguyen, 2014; Rogers et al., 2016; Simpson et al., 2016).

3.4. Governance

One of the research problems that has received particular attention is when actors and public agencies do not collaborate, and their networks are fragmented when it comes to decision-making. For instance, policies are implemented simultaneously and separately by multiple actors and agencies with different objectives. This problem curtails the capacity of adaptation of the State to cope with environmental changes; it creates and reinforces rigid institutions and centralizes decision-making in the policy networks (Armitage et al., 2011).

Collaboration occurs when rules and mechanisms of dialogue are institutionalized to make decisions and gain trust (Lubell, 2015). Trust is created as a consequence of constant interaction, in which actors expect a positive attitude from each other (Berardo, 2008; Mandarano, 2008). Most of the authors have found that collaboration between actors, through feedback processes and flexible institutions helped cope with environmental changes (Barnett and Anderies, 2014; Christie, 2005; Emerson and Gerlak, 2014; Olsson et al., 2004). Adaptive governance means that policies must be based on social capacities to respond and must be shaped by ecosystem dynamics. Structures and processes that define decision making must be oriented towards adaptation and resilience (Folke et al., 2005).

As explained by Lubell (2015), collaboration requires social learning and costs and benefits distribution. Social learning is the production and integration of knowledge by means of actors' deliberation (Steyaert et al., 2007). The information is shared between all the actors, who establish ways to share it (Leith et al., 2014; Norgaard et al., 2009). Social learning recognizes that policies are experiments, because actors learn about the successes and failures of their decisions (Munaretto and Huitema, 2012). Social learning also needs the scientists' participation, as they research the ecosystems and assess policies and management outcomes. As Stojanovic et al. (2009) suggested, scientists have to transmit information to society, and collaborate in research agendas with public agencies, local communities and private sector. Studies have identified the influence of social learning in coastal zones, which have been measured through positive environmental changes, conservation and restoration projects, and creation and management of protected areas (Dharmawan et al., 2016; Flitcroft et al., 2016; Maijerink, 2008; Mandarano, 2008).

Because governance is about trade-offs (Armitage et al., 2011), policy making involves costs for some actors and benefits for others. Collaboration aims at distributing them in the best possible way (Lubell et al., 2014). Collaboration is effective at reducing costs of money and time, especially when there are natural resources conflicts (Connick and Innes, 2003). Policies in coastal wetlands must minimize trade-offs and maximize potential complementarities (Burley et al., 2012). The distribution of costs and benefits may be viewed in common agreements, which are realized by laws, rules, plans, projects, contracts, protocols and associations (Lubell, 2000; Mandarano, 2008). A research in the Severn Estuary in Great Britain showed the need for a governance system with the ability of balancing competing interests in a complex institutional context (Ballinger and Stojanovic, 2010).

Researchers studied how the degree of centralization in a network policy is related to collaboration. Berardo (2008) demonstrated that trust building changes in dense networks, as compared to those more fragmented. In dense networks, face-to-face communication makes for easier collaboration because trust depends on the knowledge that each actor has about the others; while in fragmented networks, the trust is based on the central actors. In complex institutional systems, face-to-face communication is not possible. However, authors argue that polycentric networks—in which power is shared and well balanced—facilitate policies to create and strengthen partnerships and collaborative institutions (Mandarano, 2008; Munaretto and Huitema, 2012).

Studies have found that decentralization works if there is collaboration among all the actors at different scales. Decentralization requires local capacities, and if there are no local capacities, the

authorities fragment (Scholz et al., 2008). A study from Bangladesh revealed the disconnect between environmental and shrimp policies. It concluded that the lack of coordination restricts mangrove conservation. The authors pointed out that governance must be collaborative at multiples scales, and must also coordinate regional and national policies (Ishtiaque and Chhetri, 2016). Friess et al. (2016) studied the governance of mangrove; they found that decentralization does not necessarily resolve the lack of coordination between public agencies at different scales. If the power is not well balanced and the agencies do not share common objectives, decentralization does not work. The management of mangroves fails due to institutional rigidity, hierarchical relations, low levels of leadership, and inequality of gender and social classes (Datta et al., 2012).

Issues in governance have been researched according to the region, in different ways. In North America, researches have focused on the collaboration for the implementation of The National Estuary Program, The Clean Water Act, and Watershed plans (Lubell, 2004). In Europe, there are studies about policies in transboundary rivers, estuaries, and coastal wetlands, because different States must agree with coordinated actions to ensure adaptive management (Enemark, 2005; Kabat et al., 2012; Lillebø et al., 2016). In South and Southeast Asia, Latin America, and Africa, studies have revealed that conflicting policies of development and conservation reduce the effectiveness of the State to protect coastal wetlands (Ishtiaque and Chhetri, 2016). Research has been conducted In Great Britain, the East Asia, Oceania, and the Pacific Islands into the participation of institutions in battling climate change. These studies have indicated that science-policy interface in the governance system is a key challenge (Burley et al., 2012; Nicholls et al., 2013; Rogers et al., 2016; Sun et al., 2015).

3.4.1. Participation and co-management

Participation involves people in decision-making processes and in the activities of coastal wetlands management. Co-management is the highest level of participation, as it requires the State and local communities to reach a consensus. Due to decentralization and the polycentric governance structure, co-management establishes property rights of natural resources and distributes responsibilities to the communities in management of coastal wetlands (Datta et al., 2012; Nguyen, 2014; Olsson et al., 2004).

Participation studies have been focused on the incentives of involving people in decision-making. One of the most important incentives found in the literature is that of livelihood. If communities are aware that policies secure their livelihoods, they will be more interested in participating (Aheto et al., 2016). Another incentive is the common property regime, because controlling the territory empowers communities (Adger and Luttrell, 2000). If policies do not recognize the traditional institutions of local population, including their knowledge, the political will of participation is reduced (Barbier, 2006; Parr et al., 2011). A research from Brazil indicated that educational level and the dependence on economic activities influence participation (Reis and Incao, 2000). The study of payment for ecosystem services (PES) as an incentive for participation has been receiving increasing attention. Through the valuation of ecosystem services such as carbon storage, communities may be beneficiaries of economic contributions or projects like REDD (Reducing Emissions from Deforestation and Forest Degradation) (Alongi, 2011; Friess et al., 2016; Thompson et al., 2017; Wylie et al., 2016).

Studies about co-management have analyzed its advantages in comparison to the ones of “top-down” policies. According to Olsson et al. (2004), co-management strengthens feedbacks, produces knowledge, creates collaboration networks, and institutionalizes collective objectives of management. Investigations carried out in Ecuador showed that co-management of mangroves reinforces the interactions of communities with other actors at multiple scales, supports ancestral traditions and local rights, and reduces the over-exploitation of natural resources (Beitl, 2011, 2012). It was found that co-management involves the responsibilities of communities to monitor the territory, apply norms and traditional rules in harmony with official regulations, create local associations, and strengthen leaderships (Glaser and Oliveira, 2004). A paper explained that a comanagement system, which establishes rules about how, where, when and what people may fish, has been in existence in Sri Lanka since the XVIII century (Iwasaki, 2014). In Vietnam, studies have demonstrated that comanagement build local capacities, secure access to livelihoods, and resolve conflicts (Armitage and Marschke, 2013; Armitage et al., 2011). Co-management has four characteristics: polycentric governance, participation, experimentation for learning, and regional approach (Munaretto and Huitema, 2012).

The authors discuss the implications of incentives for participation. Some argue that economic incentives hold the risk of creating expectations and self-interests in the local population. However, there are few who argue that conservation requires being economically sustainable. If people do not have an economic motivation, they will not be involved in conservation (Aheto et al., 2016; Walters et al., 2008). However, involving people in economic activities, labor contracts, assistance programs, or paying them for conservation does not mean participation (Memon and Thapa, 2016). Incentives must not be limited to economic or financial resources; they are also regulatory, voluntary, and educative instruments (Greiner et al., 2000). Incentives, whether economic or not, strengthen people’s responsibility by making them a part in decision making. The rights and duties of the population cannot be separated. If people have rights over their territory, they have a duty towards protecting it (Glaser and Oliveira, 2004). There are cases where people protect wetlands without the support of public agencies because they value the ecosystem from an ecological and cultural perspective (Datta et al., 2012). In these cases, incentives may weaken or enhance the capacities and motivations of people to protect coastal wetlands, depending on the characteristics of each site.

3.5. Management of coastal wetlands

Ecosystem-based Management (EBM) and Integrated Coastal Zone Management (ICZM) are conceptual frameworks that have influenced scientific literature. EBM aims to maintain the functionality of ecosystems and the connectivity and processes of the elements. The management must be based on scientific knowledge for supporting ecosystem services. ICZM has been defined as a governance process in which actors negotiate their interests and take actions over a long- and medium-term. The management must be oriented to harmonize competing interests and sectors. Despite their differences, these frameworks agree with the objective of making adaptive plans (Benessaiah and Sengupta, 2014; Olsen, 2003; Olsen and Christie, 2000; Pittman and Armitage, 2016; Wasson et al., 2015).

Based on this objective, management refers to actions for the purpose of conservation, restoration, mitigation, and compensation. Scientists have studied the conservation of protected areas that comprise coastal wetlands. These areas change according to international and national regulations, human activities, and habitats and species of conservation. Protected areas may allow extractive and industrial activities, mixed uses or ban all of them (Fletcher et al., 2011; Guarderas et al., 2008). Plans of management are the instruments of conservation and restoration for protected areas, as they include zoning of uses and actions to be carried out. Studies have identified that conservation copes with several difficulties, such as lack of scientific training to design monitoring of wetlands and low economic resources. Economic resources facilitate operation of public agencies, project implementation and land acquisition. On the other hand, low funding reduces the capacity to protect wetlands. Besides, the studies have explored the effectiveness of coastal wetlands conservation, and assessed environmental changes after the creation of a protected area (Aung, 2007; Sun et al., 2015).

Moreover, the authors who research management of coastal

wetlands have analyzed restoration. The function of restoration aims at reestablishing the natural conditions of ecosystems (Zedler et al., 2012). Some authors compare restoration with rehabilitation; while the former means returning to a natural state, the latter means replacing the structure and functions of the ecosystem (Dale et al., 2014). However, most of the authors agree with the idea that it might be very difficult for a degraded or lost wetland to return to its original state because of irreversible impacts. For this reason, restoration policies must implement an adaptive plan of management, congruent with the particularities of each site, with viable objectives and reliable assessments (Liu et al., 2016). To be adaptive, restoration management must take into account biological considerations about species of vegetation, and physical variables such as frequency and levels of flooding, sedimentation transport, and extreme events (Primavera and Esteban, 2008).

There are authors who discuss if restoration must remove or modify embankments, with the aim of recovering the connectivity of wetlands with the rivers and sea; they also discuss how to restore wetlands that were reclaimed for urban and agro industrial uses. According to Erwin (2009), management has three options: to reinforce and build dikes, to realign dikes, or to restore wetlands. This decision depends not only on the adaptive capacity of each community, but also on the availability of scientific knowledge about hydrological and oceanographic processes. Hence, a lack of scientific knowledge about the height, materials, and location of dikes affects adaptation and may increase risk of environmental problems (Bao and Gao, 2016).

Restoring wetlands requires a territorial planning since it establishes the spatial realignments, the regulations about dikes, and the relocation of activities and infrastructure. Restoration of reclaimed wetlands faces several obstacles because relocation activities and infrastructure are controversial; social preferences are opposed to this since relocation implies land use changes, and decision makers must consider trade-offs and choose the most economically feasible option. Authors consider impacts of climate change and disasters more expensive than restoring wetlands. The benefits of improving the ecosystem's wetlands are superior to the costs of not doing it (Bauer et al., 2004; Faraco et al., 2016; Ferreira and Lacerda, 2016). A sustainable engineering is promoted in management because of its cost-benefit, as it includes actions such as recharge of sediments, restoration of flood prone areas, mobilization of dunes, and amplification of estuarine meanders (Pethick, 2002). In Denmark, for instance, there was a shift in policy from drainage to the return of wetlands. To achieve this goal, there were projects of restoring meanders of regulated rivers and establishing wetlands that were reclaimed in the past (Neilsen, 2002).

The connectivity is vital for management, as it concerns actions in ecological corridors outside of coastal wetlands. It has been demonstrated that connectivity is essential for functions underlying key ecosystems services (Barbier et al., 2011). For connectivity, a regional approach of policies is important, one which involves actors at multiple scales. In the terrestrial zone, recognizing the river basis as a unity spatial permits actions in rivers, streams and riparian vegetation connected with wetlands. In marine zones, connectivity is related to the mobility of species, and the chemical and physical parameters of tides (Erwin, 2009; Gopal, 2013; Hodge and McNally, 2000; Nguyen, 2014).

Most of the authors agree that conservation and restoration policies must be processes of long-term, as environmental changes do not occur immediately. In addition, assessing management results requires monitoring and scientific research on a permanent basis (Nicholls et al., 2013; Pethick, 2002; Sun et al., 2015). It is carried out to check environmental changes, verify effects of management actions, and control urban and economic activities. In coastal wetlands, it facilitates assessment of the results of conservation and restoration policies (Hallett et al., 2016).

The study of management of coastal wetlands comprises the analysis of discharge mitigation by urban, agricultural and industrial sources (Zedler et al., 2012). An investigation of mercury pollution in the United States defined mitigation as all the activities that moderate the intensity of impacts. The authors discussed mitigation measures such as dredging, capping sediments, controlling watershed runoff, and changing impoundment management (Lambert et al., 2012). The policy of "No net loss" in the United States is an interesting case studied by scientists working on mitigation and compensation. The policy demands that wetlands have to be restored; if they cannot be restored, the developer has to improve environmental conditions of other wetlands, create new wetlands, or invest in a mitigation bank. Discussions about compensation try to understand how to estimate the net loss of a wetland, both in extension and ecosystem functionality. Estimating net loss is important to decide where, how much space, and what to do in order to compensate for the loss of wetlands (Ravit and Weis, 2014; Zedler et al., 2012).

Mitigation and compensation are themes studied especially in urban zones. It has been particularly found that the problems of wetland management in cities are very different from that of rural zones, where there is not a significant population. In cities, coastal wetlands have been reclaimed, or at least their extension and functionality have been reduced. Urban zones reclaim coastal wetlands through embankments; they are also replaced by houses, malls, hotels, industries, infrastructure of transport such as ports, airports and freeways (Xue et al., 2004). However, coastal wetlands can be declared as protected areas in cities. They may constitute ideal spaces for recreation, environmental education, and ecotourism (Colten, 2002).

Management issues have been studied almost every time with other themes of research, except for in North America and the West of Europe. In these regions, studies have assessed outcomes of management options, especially in the restoration of reclaimed wetlands and compensation projects. In Oceania and the Pacific Islands, East Asia, and Great Britain, studies have been more interested in the governance structure, especially the management as a product of the interface of science policy. In the regions of Latin America, Africa, and South and Southeast Asia, researches have been more related to the study of the local population. Researchers have found that when management is particularly characterized by the conflictive overlapping of multiple actors, the local population becomes a central actor for developing conservation actions.

3.5.1. Adaptation to climate change

The increased attention to adaptation is probably related to catastrophes such as the Indian Ocean earthquake and tsunami in 2004, Hurricane Katrina in 2005 and other hurricanes and storms; the Deepwater Horizon oil spill in 2010, typhoons and floods in Asia, and so on. The disasters seemed to imply that coastal wetlands may serve as protective barriers in the face of hazards, especially in face of climate change (Alongi, 2008; Barbier, 2006, 2011; Barbier et al., 2011; Dahdouh-Guebas et al., 2005; Kates et al., 2006). Many studies refer to the effects of climate change in coastal wetlands and some have analyzed the policy framing. Coastal wetlands are exposed to disappear, reduce their extension, and change their environmental conditions. Impacts of climate change result in SLR, growing intensity and frequency of storms, alteration of climatic conditions, increasing forest fires, changes in CO2 concentration, and in ocean circulation zones (Alongi, 2008). Local population is exposed to impacts of climate change in coastal wetlands, especially if people, such as artisanal fishers and farmers, are highly dependent on natural resources. Policies must consider vulnerability and capacities of local population in the face of climate change (Kalikoski et al. 2010).

The effectiveness of hard adaptation strategies, such as hydraulic structures in ocean and coastal zones, is uncertain due to limited projections of SLR (Burley et al., 2012). Territorial planning will have to deal with coastal squeeze, and consider the realignment of coasts according to their environmental conditions (Doody, 2013; Nicholls et al., 2013; Pethick, 2002). In urban zones, coastal wetlands must be restored to build adaptation in the face of SLR and extreme storms in order to

prevent disasters that may cause loss of lives and properties (Ravit et al., 2015). Gilman et al (2008) and Erwin (2009) proposed adaptation measures for policies in coastal wetlands: eliminate non-climate stresses, control human activities in river basins, territorial planning of activities retreat for the SLR, build infrastructure protection, create new protected areas, restore reclaimed wetlands, establish monitoring networks, conduct research, and spread environmental education. PES constitutes a strategy for conservation in the face of climate change. It can value the service of carbon storage and define the key role of wetlands in adaptation (Alongi, 2011). Including the service of carbon storage in policies will benefit restoration projects, influence decisions, and identify ecosystem needs (Rogers et al., 2016; Thompson et al., 2017; Wylie et al., 2016)

4. Conclusions

The review identified research themes of policies relating to coastal wetlands and described particularities in the agendas of research, according to the regions of study. This review indicated that studies about policies pertaining to coastal wetlands have increased in the last five years. At present, scientists are researching multiple problems with the help of interdisciplinary or transdisciplinary approaches. This is in stark contrast to the past when studies focused only on one theme from a given discipline.

The theme of development has explored how policies promote urban and economic activities, which may cause impacts on coastal wetlands. Publications have shown that policies create incentives for people and private sector, and finance infrastructure construction to facilitate the occupation of zones with coastal wetlands. The key challenges are related to the integration of environmental protection in the incentives for a sustainable development, and to the infrastructure construction respecting the ecosystem functioning.

The territorial planning comprises the study of delineating coastal wetlands and zoning them, property regimes, and the conflicts arising due to the access and use of natural resources. Authors explained that economic and political interests influence territorial planning, but it faces the challenge of being congruent with the natural dynamics that configure the landscape of coastal wetlands. Studies have concluded that territorial planning also faces the challenge of institutionalizing protection mechanisms outside of coastal wetlands, i.e., river basins and the oceans that are interconnected. SLR poses the challenge of delineating coastal wetlands, considering the spatial changes that may occur in the next years. The researches about property regimes for natural resources have exposed that policies have the added challenge of strengthening the territorial control by communities and authorities, avoiding which coastal wetlands become spaces of open access.

The local population is most studied in Latin America, Africa, and South and Southeast Asia. Authors research how governmental programs incite people to cause environmental changes, whether positive or negative. The authors discuss how the narratives of policies for development and the lack of livelihood force the conversion of wetlands for other land uses. The symbolic power of policies influences the behavior of actors in coastal wetlands' management. Studies have found that policies for conservation are successful when livelihoods, social and cultural services, LEK, social perceptions, and cultural and social variables are taken into account.

Policies relating to coastal wetlands must build adaptive governance, which is collaborative, multilevel and decentralized. The studies of governance demonstrated that institutions are adaptive due to feedback that is generated by collaboration between actors who trust each other. A considerable number of publications were found about social learning and the influence of science in governance. The studies explained that science has the challenge of encouraging social learning, promoting the monitoring of ecosystems, and diffusing information. There were authors who suggested that policies must be based on polycentric governance, and the power has to be distributed among the actors who participate in the management of coastal wetlands. Distribution of power means to integrate local population through participation strategies and co-management. Policies have the challenge of creating and implementing incentives of participation, based on the identification of social preferences and the factors that motivate people to be involved. Experience of co-management in Asia and Latin America have revealed positive results protecting coastal wetlands, compared to policies that exclude local population in decision-making. It is a challenge for decision making to establish policies based on co-management.

Policies of coastal wetlands requires strengthening institutional capacities to manage protected areas, establish restoration plans with viable objectives, and determine adequately measures to mitigate and compensate impacts. Environmental policies face the challenge of implementing ecosystem based-management approaches, because decision-making must recognize the ecosystems as unities of territorial planning. In the face of climate change, policies must create and maintain conditions to coastal wetlands in order to adapt to SLR and the increase in temperature. Although there is incertitude about the complexity of effects of climate change on coastal wetlands, it is important to take preventive actions.

Finally, there are open areas for research that must be strengthened in the academic agenda. These are related to the Ecosystem-based Adaptation, the mismatches of policies and governance with ecosystems, the differences of management according to all types of wetlands, the promotion of a sustainable engineering, the territorial planning of coastal zones in the face of SLR, and the building of a symbolic narrative in policies of coastal wetlands that recognizes the contribution of ecosystem towards people.

Declarations of interest

None.

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